

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

PROJECT SUMMARIES

Today, heavier loads, increased traffic and higher speeds are placing greater demands on American's overcrowded highways, roads and streets. Improvements to current concrete pavement technology are needed. To this end, the Transportation Equity Act for the 21st Century (TEA-21) provided \$30 million, \$5 million per year, to "carry out research on improved methods of using concrete pavement in the construction, reconstruction, and repair of Federal-aid highways."

To carry out the research specified in TEA-21, the Federal Highway Administration (FHWA), in partnership with states, industry and academia developed an ambitious program to carry out the TEA-21 mandate. The Concrete Pavement Technology Program (CPTP) consists of research, development, and technology delivery activities to improve the performance and cost-effectiveness of concrete pavements.

The CPTP has four goals:

Reduce user delays
Reduce costs
Improve performance
Foster Innovation

These goals address the needs of the State departments of transportation, the concrete pavement industry, and the highway user, while supporting the FHWA's strategic goals to improve the mobility, productivity and safety of the Nation's highway system. In June of 2002 the cooperative agreement between FHWA and IPRF was terminated, however, FHWA remains committed to continue vital research needed to reach the goals of the CPTP.

The CPTP will produce practical and readily useable tools, guidelines, procedures, methods and software to be used in the material selection, mix design, pavement design, construction, and operation of concrete pavements.

Over 30 projects identified in the CPTP are in progress. The attached project summary sheets highlight the goals and progress for each project.

This status report was prepared for the March 17-18, 2003 meeting of the TRB Committee for Research on Improved Concrete Pavements.



CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Traffic Management Optimization Pilot Studies for Reconstructing Urban Freeways

TASK /STUDY NUMBER: Task 1(99)

OBJECTIVE: Demonstrate construction processes and traffic management strategies aimed at minimizing traffic and user disruption.

BACKGROUND: Often the temporary disruption caused by reconstruction of pavements results in costs to the highway user and the local community that dwarf the capital cost of renewal. Concrete pavement contractors suggest that there are variety of innovative construction methods and traffic management methods possible to reconstruct a meaningful section of urban freeway with long-life pavement. Unfortunately, there is general skepticism amongst some engineers that long-life pavement reconstruction can be accomplished at minimal user disruption. Success in providing a quality long-life pavement with minimal user disruption would significantly improve safety and substantially reduce user costs because these routes will be open to serve traffic. Worker safety may also be improved by reducing workers' exposure to traffic during construction.

SCOPE OF WORK:

- Surveys of motorists and residents
- Pilot project(s) on urban highways to demonstrate traffic-management optimization principles
- Documentation of planning and construction processes and logistics on pilot projects
- Conceptual studies to determine and document traffic management options on reconstruction projects in the planning phase. Key deliverables are development and refinement of the matrix tool, which is intended to guide decisions on public involvement approaches.
- Technology transfer information, including a national open house on a pilot project. Technology transfer products may include but are not limited to reports, summary papers, brochures, posters, audio/visual (A/V) presentations, slide shows, videos, CD-ROMs, DVD-ROMs, and/or a World Wide Web site.
- Not included in this project: Develop scope, cost, and schedule for technology transfer (see Task 65).

PERIOD OF PERFORMANCE:

01 April 2003 31 March 2005

COST:

- \$421,830 (includes 20% match)

CONTRACTOR/PRINCIPAL INVESTIGATOR:

- Texas Transportation Institute / Stuart Anderson

STATUS: A contract, including a revised and updated statement of work, was awarded to Texas Transportation Institute with a 2-year period of performance as shown above.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Impact of Texturing and Surface Treatment on Reducing Wet-Weather Accidents

TASK / STUDY NUMBER: Task 2(99)

OBJECTIVE: This project will review accident data from pavements of varying surface treatments. The data will be analyzed to determine a relationship between surface type, noise, surface texture, and wet-weather accidents. Guidelines will be developed for optimal surface textures.

BACKGROUND: The different methods of creating the macro-texture portion of pavement surface textures have not been correlated to a reduction in wet-weather accidents. A study to analyze the correlation will determine the different impacts of each type of surface texturing method to wet-weather accidents. The study is to primarily focus on the macro-texture component of surface texture for concrete pavements related to wet-weather accidents.

STATUS: Canceled on Jan. 23, 2002.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Performance and Design of Whitetopping Overlays for Heavily-Trafficked Pavements

TASK /STUDY NUMBER: Task 3(99)

OBJECTIVE: The research effort for Task 3(99) has four major objectives.

- To document, based in part on available data, the performance of the three classes of whitetopping overlays: ultra-thin (less than 4 inches), thin (4 to 8 inches), and conventional (greater than 8 inches).
- To develop a design procedure, for each class, that takes critical parameters and site conditions, into account.
- To develop best practice construction, and quality control guidelines ensure that quality whitetopping pavements are built.
- To identify potential rehabilitation alternatives, and solutions.

BACKGROUND: Whitetopping has been used extensively throughout the United States. The design of these overlays has been based on conventional procedures, which assumes the existing asphalt pavement is a stabilized base course. In many instances, all three classes of whitetopping have exceeded their design expectations. Research is needed to determine an appropriate mechanistic design procedure. In addition to the design procedure, research is needed to identify the existing-pavement conditions that influence whitetopping performance for each class of overlay.

SCOPE OF WORK: Based on available data (and additional data collected on about five projects) document the performance of three broad classes of whitetopping overlays. Develop a mechanistic whitetopping design procedure for each class of overlay that takes into account the critical parameters and site conditions. Develop best practices construction and quality control guidelines that address the issues needed to ensure a quality pavement is built. Identify potential rehabilitation alternatives for each class of whitetopping. Specific items to include in each are best practices, sensitivity to conditions and design parameters, quality control, possible problems as well as the probable solutions.

START DATE: February 2000

DURATION: 18 Months (extended to 29 months through July 2002)

COST: \$359,900

CONTRACTOR/PRINCIPAL INVESTIGATOR: Transtec, Inc./Dr. Robert Otto Rasmussen

STATUS: At the panel meeting in May 2002, the latest version of the software and the construction and rehabilitation guidelines were presented and distributed on a CD. The contractor has invoiced IPRF for the full contract amount. IPRF informed the FHWA that the final products would be completed and delivered to FHWA at a future date. No delivery date has been established.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Tests or Standards to Identify Compatible Combinations of Individually Acceptable Concrete Materials

TASK / STUDY NUMBER: Task 4(99)

OBJECTIVE: The objectives and expected results of this research are to develop practical test procedures and criteria to assess the effects of combinations of materials for concrete pavements on:

- Early stiffening and excessive retardation that can affect workability, placeability, consolidation, and finishing
- Potential for early-age cracking, including plastic shrinkage, and possibly the ability to attribute the cause of cracking to chemical, physical, and environmental phenomenon
- Characteristics of the air void system, including non-uniformity, insufficient air, coalescence of air voids around aggregate, and excessive large air voids, all of which influence strength or durability or both

BACKGROUND: Frequently, field experience has indicated that certain materials combinations may result in undesirable effects on concrete properties such as early stiffening (false set or flash set), inadequate or excessive retardation, excessive cohesiveness, problems with air entrainment, loss of workability, lower than expected strength, and unexpected cracking at early ages.

Reliable tests are needed to predict potential incompatibility of concrete materials that adversely influence the fresh and hardened properties of concrete at early ages. For example, combinations of incompatible materials may lead to early stiffening and unworkable concrete. ASTM C 359 was developed to evaluate early stiffening of portland cement and may not be applicable for evaluating combinations of cementitious materials and the interaction with chemical admixtures. A recent approach that may be more applicable to a combination of materials is the mini-slump cone test. No test exists to predict the potential for plastic cracking or early age hardened concrete cracking due to chemical, physical, or environmental phenomena. There is also no test to evaluate the potential for coalescence of air voids around aggregates, an unstable air void system under placement and consolidation, or a process that identifies an air void system in fresh concrete that will be detrimental to durability, strength, or both.

This research effort should produce tests and procedures to enable material suppliers, concrete producers, and users to identify undesirable material combinations that adversely affect the early-age properties of concrete, evaluate the uniformity of individual materials from the same source, and optimize the combinations for predictable early-age performance. Cracking and durability-related distress in the long term (later ages) is not included in the scope of this project

SCOPE OF WORK: In phase I, the researchers performed a comprehensive literature review and developed a work plan for phase II to develop simple test methods for evaluating compatibility of combinations of concrete component materials in paving concrete mixtures relative to the three focus areas listed in the objective. The effects of other factors such as production and placement methods, factors that influence finishability, and the influence of environmental conditions such as temperature and humidity will be evaluated. Deficiencies in existing test methods for assessing the suitability of materials for making concrete will be identified. The procedures that are developed will be incorporated into guidelines to evaluate and qualify combinations of materials for use in concrete pavements. The researchers will propose methods for disseminating the information developed herein (technology transfer) to producers, contractors, and users.

START DATE: Project to restart March 2003

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Accelerated Loading Tests of Ultra-Thin Whitetopping (UTW)

TASK /STUDY NUMBER: Task 5(99)

OBJECTIVE: Verify and/or calibrate existing UTW design procedures using testing data from the ultra-thin overlay projects at FHWA's Turner-Fairbank Accelerated Loading Facility.

BACKGROUND: Ultra-thin whitetopping overlays are relatively new composite pavement designs using 2- to 4-inch thick concrete overlays of asphalt pavements. The original ultra-thin overlay concept, developed in 1990, was for light traffic situations. In practice, some ultra-thin projects have been constructed on heavy-truck ramps, and even high-speed highways. Early performance of these pavements has been excellent, exceeding most expectations. Full-scale load tests were conducted from May 1998 to December 2000 at FHWA's Turner-Fairbank Highway Research Center under a Cooperative Research Agreement between FHWA and the American Concrete Pavement Association. Analyses of these test results, isolated performance intricacies, revised existing design procedures, and calibrated models.

SCOPE OF WORK:

- Conduct complementary tests at the ALF facility, including bond pull off, spectral analysis, Falling Weight Deflectometer, and Demec joint and crack openings.
- Use data from tests to verify/calibrate existing UTW design procedures
- Conduct technology transfer workshop
- Produce and distribute technology transfer documents

PERIOD OF PERFORMANCE: 1999 – 2001 (revised to 2003)

COST:

- \$200,000 for testing at FHWA's Turner-Fairbank facility and analysis of the data
- \$35,000 for technology transfer workshop
- \$48,000 for other technology transfer
- \$283,000 total allocation for task

CONTRACTOR/PRINCIPAL INVESTIGATOR:

Transtec, Inc. / Robert Rasmussen

STATUS: Load testing, and supplementary data collection is complete. The data from the ALF tests was analyzed as part of Task 3. A technology transfer workshop was conducted in October 1999. The IPRF Contractor Transtec made several site visits to the FHWA's ALF to collect joint opening and bond data. The contractor included these results in the Task 3 interim report. The deliverables from this task will include an Executive Summary, an ALF UTW database, and recommendations and concepts for technology transfer materials. It is also anticipated that these materials will include a set of summary brochures and sheets, plus electronic presentations of the final results.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Incremental Costs and Performance Benefits of Various Features of Concrete Pavements

TASK / STUDY NUMBER: Task 6(99)

OBJECTIVE: To determine the most cost-efficient combination of design features for concrete pavement, considering estimated costs and expected performance improvements of each feature.

BACKGROUND: There are a variety of design choices or features available for concrete pavement. A standard design using certain features is often propagated by a state agency for use system wide. In many cases these standard designs remain constant over many years. Eventually, there may become little institutional knowledge of the purpose and interrelationship of the standard sections' features, particularly on expected cost and performance. To apply the most cost-efficient combination of features and requirements, it is necessary to know how each impacts initial construction cost and pavement performance. While there have been several feature performance studies in the past, including those in LTPP, cost aspects have been largely ignored. Until the costs and benefits of design and requirement features are examined together, the issue of performance optimization will remain unclear. This project will address this gap in knowledge.

SCOPE OF WORK:

- Conduct limited review of related work.
- Prepare and submit data collection plan for approval.
- Survey construction contractor estimators for relative construction costs for the range of features.
- Tabulate the relative cost of various pavement components on a state, regional, and nationwide basis.
- Survey, tabulate, and summarize the performance expectations (based on expert opinion) of highway pavement design personnel for each feature. Compare these results with results done by others (i.e. LTPP studies).
- Prepare and submit interim report.
- Develop computer software capable of evaluating the impact of design features based on user input.
- Present project findings and draft final products to task panel.
- Prepare and submit final products.

PERIOD OF PERFORMANCE: August 2000 – June 2003

COST: \$174,431.64

CONTRACTOR / PRINCIPAL INVESTIGATOR: Applied Pavement Technology / Kurt Smith

STATUS: The project commenced in August 2000 with review of previous works and development of the data collection plan. A limited literature review was completed in January 2001, and the results are available to interested parties in PDF electronic file format. In February 2001, the researcher completed the data collection plan, including detailed cost and performance estimating forms. Data collection was initiated in March 2001. Of 35 contractors who volunteered to provide relative cost estimates, 18 actually did so by responding to the questionnaire that was sent to them. Of 23 agency engineers who volunteered to provide performance estimates, 15 actually did so by responding to the questionnaire. An interim report was completed in March 2002. Software capable of evaluating the impact of design features is being finalized. A draft final report will be submitted in March 2003, and a final meeting of the advisory panel will be held shortly thereafter. Percentage of work completed: 72% (as of 2-26-03)
Percentage of total funds spent: 69% (as of 2-26-03)

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Field Trials of Concrete Pavement Product and Process Technology

TASK /STUDY NUMBER: Task 7(99)

OBJECTIVE: Conduct field trials of new products, processes, and technologies in actual construction projects.

BACKGROUND: In many cases implementing new technology into the highway industry presents a major challenge: A contractor cannot use technology unless it is specified, but a state cannot specify or allow a new technology until it is tried and proven. Task 7 seeks to encourage state agencies to partner with their local contractor and material/equipment supplier constituents to implement new or improve existing technology. Through open solicitation, public and private agencies can seek funding to try new or improved concrete pavement technologies in field conditions. Reports, photos, video, and written reports will capture each effort for education and technology transfer.

SCOPE OF WORK:

- Select candidate projects based on set criteria
- Monitor projects for minimum of three years
- Compose reports: construction report, yearly evaluation reports, and a final report
- Develop publications that contain recommendations and findings

PERIOD OF PERFORMANCE:

27 March 2000 – 31 December 2000, Construction Technology Laboratories (9 months)

26 June 2000 – 26 June 2003, University of Washington

01 May 2001- ????, Construction Technology Laboratories

COST:

- \$96,000 Project Management contract (Peak Management Associates)
- \$55,000 UTW Repair Techniques research contract
- \$60,000 Weekend Intersection Reconstruction
- \$99,000 Instrumentation of UTW in Colorado
- \$99,321 Precast Concrete Slabs for Full Depth Repairs
- \$85,141 Implementation of TEMP System
- \$100,000 Magnetic Tomography for Dowel Bar Location
- \$100,000 Field Evaluation of Elliptical Steel Dowel Performance
- \$100,000 Evaluation of PRS in Tennessee

CONTRACTOR/PRINCIPAL INVESTIGATOR:

- UTW Repair Techniques (Construction Technology Laboratories/Shiraz Tayabji)
- Weekend Intersection Reconstruction (University of Washington//Kamran Nemati)
- Instrumentation of UTW in Colorado (Construction Technology Laboratories/Chung Wu)
- Precast Concrete panel System for Full Depth Repairs (Michigan State University/Neeraj Buch)
- Implementation of TEMP System (Transtec Group/Rob Rassmussen)
- Use of Magnetic Tomography to Evaluate Dowel Bar Placement (ERES/Lev Khazanovich)
- Field Evaluation of Elliptical Steel Dowel Performance (Iowa State University/Jim Cable)
- Evaluation of PRS in Tennessee (ERES/Nasir Gharaibeh)

STATUS:

- Project Management contract with Peak Management was cancelled by IPRF
- UTW Repair project is complete; report and video are available
- Weekend intersection reconstruction is report/video is finished
- Instrumentation of UTW in Colorado is approximately 70% complete, final report is expected in late 2003.
- Precast Concrete Slab project was awarded to Michigan State University on March 4, 2003
- Remaining contracts awarded in March/April 2003

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Performance and Design of Separated (Unbonded) Concrete Overlays

TASK /STUDY NUMBER: Task 8(99)

OBJECTIVE:

1. Document the performance history of separated (unbonded) overlays subjected to high truck volumes.
2. Document the design parameters, site conditions, materials properties, etc. that relate to long-term performance of separated (unbonded) overlays.
 - a) Interlayer (role, characteristics, materials, thickness, QC /QA testing)
 - b) Overlay Materials
 - c) Environmental Factors
3. Develop field-validated, mechanistic-based design models consistent with the proposed 2002 Pavement Design Guide for separated (unbonded) overlays that predict the overlay response to environmental and wheel loads, considering interlayer and overlay materials.

BACKGROUND: Unbonded concrete overlays of concrete pavements have been used since the early 1900's. These overlays contain a separation interlayer between the old and new concrete layers that unbonds the two concrete layers and prevents the joints and cracks in the underlying concrete pavement from reflecting into the new concrete overlay. Currently, separated concrete overlays are designed without considering the effects of interaction between the overlay and the underlying pavement.

In addition, recent research with ultra-thin whitetopping suggests that short joint spacing plays a major role in the performance of thin concrete overlays

SCOPE OF WORK: This project will develop analytical models and mechanistically based design procedures that accurately predict the response of separated overlays to wheel and environmental loads. It is anticipated that two major items will be researched:

1. Does interaction between the overlay and old concrete add to the structure of the pavement system, and if so, how much and how can it be accounted for?
2. Does short joint spacing and bonding interaction affect unbonded overlays in a similar manner as ultra-thin whitetopping?

It is anticipated this project will consist of analytical work, full-scale instrumentation, and load testing as well as collection, documentation, and analysis of field performance data for improving overlay thickness design procedures

START DATE: After public availability of proposed 2002 Design Guide

DURATION: 30 Months

COST: \$500,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: TBD

STATUS:

This project was previously solicited by IPRF but must be re-competed consistent with Federal procurement regulations. As this project is dependent on the content of the proposed 2002 Pavement Design Guide this project will be deferred until the proposed 2002 Pavement Design Guide is publicly available. The Guide is anticipated to be publicly available in mid to late 2003.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Influence of Sealing Transverse Contraction Joints on the Performance of Concrete Pavement

TASK /STUDY NUMBER: Task 9(00)

OBJECTIVE: Examine the effect of sealing transverse contraction joints on long-term pavement performance using existing test sections.

BACKGROUND: Currently, 96 percent of the state highway agencies require transverse joint sealing, adding about 2 to 7 percent to the initial construction cost of their pavements and even more when considering resealing activities and life-cycle cost analysis. If the use of narrow, unsealed joints on short jointed concrete pavements can provide equally long-term pavement performance as sealed joints, states can save millions of dollars in construction and maintenance costs by eliminating joint sealing on those projects. Reduction in traffic delays during sealant maintenance and increases in worker safety are possible benefits from the elimination of sealants where they are not found cost-effective.

SCOPE OF WORK:

This project is intended to address the following questions:

1. What is the effect on long-term pavement performance of unsealed transverse joints in concrete pavements with different pavement cross-sections and slab dimensions, traffic levels, and climatic conditions?
2. What is the effect of different transverse joint sealant materials and configurations on the long-term performance of concrete pavements in various climatic conditions (climatic zones)?
3. Is sealing contraction joints cost effective for different pavement designs and materials over a range of climatic zones and traffic levels?

PERIOD OF PERFORMANCE: Not started, expected duration: 3 years

COST: \$400,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: ProTech Engineering/Dr. Kathleen T. Hall

STATUS: The contract for this project was awarded in March 2003.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Revision of I-Slab 2000 for Subbase/Pavement Interaction

TASK /STUDY NUMBER: Task 10(00)

OBJECTIVE: Revise the I-Slab 2000 analysis program to account for interaction between the concrete slab and the underlying layer.

BACKGROUND: One of the main drawbacks of many finite element programs is their ability to adequately model the interface condition between the PCC slab and the underlying layer. The existing finite element programs for pavement analysis assume either zero or full bond (no slippage) for the interface condition. In reality, the amount of layer slippage under a heavy wheel load is somewhere between these two extremes. Having a capability to model and specify the varying levels of slippage between the slab and an underlying layer would greatly improve our ability to fine tune concrete pavement design.

SCOPE OF WORK:

- Modify ISLAB-2000 analysis program and graphical user interface to allow modeling of concrete slab and underlying layer to better account for interaction
- Perform trial runs and sensitivity studies to ensure the program is performing as expected
- Deliver revised program and documentation for unlimited license for use by ACPA

PERIOD OF PERFORMANCE: 2 June 2000 –2 Sept. 2001, ERES Consultants, Inc.

COST: \$40,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: ERES Consultants, Inc. / Lev Khazanovich

STATUS: An appropriate mathematical model has been identified, involving a 40 degree-of-freedom stiffness element to address layer interaction. The ISLAB-2000 computer code has been modified to include the layer interface model. The ISLAB-2000 graphical user interface (GUI) has been modified to allow the user to enter new structural model parameters (friction parameters, horizontal joint stiffness, horizontal restraint).

Testing and verification of the program is now underway. The graphical postprocessor has been modified to better report the output of the new computations.

The Users Guide and installation CD were received Aug. 14, 2002. New model verification is underway at Minnesota DOT and Michigan DOT/Michigan State University. The program will be released to public after verification and any necessary corrections.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Workshops on Concrete Pavement Technology for State DOT Pavement Engineers

TASK /STUDY NUMBER: Task 11(00)

OBJECTIVE: Conduct two-day workshops on current concrete pavement technology for state DOT engineers.

BACKGROUND: Improvements to the design, construction, rehabilitation, and asset management of concrete pavements will only be made when technological advances are put into use. State Departments of Transportation are the primary agents for such advancement as they are responsible for building and maintaining the large majority of highways in the U.S. Therefore, it is essential for key state DOT engineers to become familiar with new concrete pavement technology. One effective method for transferring technology is through workshops. Workshops are effective when leading authorities present new technology, followed by ample time for participants to share experiences and viewpoints. However, this format is only effective in changing DOT practices when key state DOT staff members are participants. It is important that the right representatives from the state DOTs, as well as pavement experts from the FHWA Regional Resource Centers, participate. Additionally, college professors of civil engineering can educate students on new technology. University professors, who teach pavement technology, are invited for updates on the latest advances in concrete pavements, including products and findings from the Concrete Pavement Technology Program.

SCOPE OF WORK:

- Plan, organize, and conduct an annual two-day workshop on concrete pavement technology for state DOT pavement engineers.
- Plan, organize, and conduct an annual two-day workshop on concrete pavement technology for college professors teaching pavement engineering.

START DATE: June 2000 for 2000 Workshop for DOT pavement engineers. 2000 Workshop held on August 10-11 April 2001 for 2001 Workshop for DOT pavement engineers. 2001 Workshop held June 28-29

April 2001 for 2001 Professor's Seminar. 2001 Professor's Seminar held June 18-20, 2001

DURATION: Annual State DOT Workshops for 4 years. Professor's Seminar in 2001

COST: \$60,000 in FY00, \$105,000 in FY01

CONTRACTOR/PRINCIPAL INVESTIGATOR: American Concrete Pavement Association

STATUS: The first state DOT workshop, entitled "Concrete Pavement Design – 2000 and Beyond" was held August 10-11, 2000, in Breckenridge, Colorado. Many positive comments were received from participants regarding the workshop's format, discussion topics, and quality of presentations.

The second state DOT workshop was held in San Francisco, CA on June 28-29, 2001. The 2001 Professor's Workshop took place on June 18-20, 2001 in Skokie, IL.

No further activity is anticipated

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Develop a Plan to Investigate the Impacts of Pavement Cracking on Long-Term Performance

TASK / STUDY NUMBER: Task 12(00)

OBJECTIVE: Conduct a thorough literature search and compile a summary report of the impacts of pavement cracking on long-term concrete pavement. Prepare a research plan to address the impacts of pavement cracking on long-term performance.

BACKGROUND: Uncontrolled cracking in concrete pavements can be the result of many factors. While such cracking is undesirable, the long-term effects on pavement performance and durability are not clear. Key questions include: What type of cracks affect pavement performance and durability? How does cracking affect performance of pavements built on different bases? How many cracks can be tolerated without significantly affecting ride quality? When is crack repair or slab replacement needed?

SCOPE OF WORK: Purchase orders issued to two researchers, with recognized expertise, to perform the literature search and prepare independent plans for the needed research.

PERIOD OF PERFORMANCE: October 2000 – November 2000

COST: \$5,000 each, Total - \$10,000

CONTRACTOR / PRINCIPAL INVESTIGATOR:

Construction Technology Laboratories, Inc. / Shiraz Tayabji
ERES Consultants, Inc. / Michael Darter

STATUS: The feasibility studies were completed and both concluded that enough information was available to determine the potential for success of a study of the impact of cracking on pavement performance. This task is now complete.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Determine Actual Life Cycle Costs

TASK /STUDY NUMBER: Task 13(00)

OBJECTIVE: Select and perform comprehensive life cycle cost analyses for three specific highway sections, and distribute reports disclosing the results.

BACKGROUND: Many state DOTs have developed life cycle cost analysis models. Some additional guidance has been provided by FHWA, but, in general, life-cycle costs models vary considerably across the U.S. As with any prediction model, actual performance information is needed for verification and calibration. Very little actual life cycle cost information is available to check the reasonableness of LCCA models.

SCOPE OF WORK:

- Identify three candidate highway sections for LCC analysis.
- Thoroughly review historical data, compiling the actual schedule and costs of building and rehabilitating these sections of highway.
- Establish the actual life cycle costs of the highway sections using established LCCA principles, and prepare appropriate reports.

PERIOD OF PERFORMANCE: 1 August 2000 – 31 January 2002, ERES Consultants, Inc. (1.5 years)

COST: \$180,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: ERES Consultants, Inc.

STATUS: This 100% industry funded project will be completed by IPRF. Deliverables will be provided to FHWA.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: AURORA 2000 Pavement System Analysis Tools

TASK / STUDY NUMBER: Task 14(00)

OBJECTIVE: Develop a set of system analysis tools for pavements

BACKGROUND: The work was initiated in 1997 to develop a state-of-the-art, mechanistic pavement design selection and evaluation system. During the course of the work, it has evolved into a system of tools which address planning, design, construction, and economics and packages these tools in a common, user-friendly Windows interface

SCOPE OF WORK:

Products include:

1. Aurora 2000 System Software
2. Decision Maker Derivative Software (utility theory)
3. Traffic Management & Cost Analysis Tool
4. Specification/Special Provision Development Tool

START DATE: October 1997

DURATION: 3 years

COST: \$2,610,000 (IPRF/industry funds)

CONTRACTOR / PRINCIPAL INVESTIGATOR: Transtec, Inc./Dr. Robert Rasmussen

STATUS: As the result of a technical review by the project panel, the final deliverables were submitted on September 29, 2000. Software was demonstrated to federal and state DOT and industry representatives at San Francisco Technology Transfer Workshop on June 28-29, 2001. Project is complete.

Contract to perform Independent Evaluation of Aurora 2000 is currently advertised

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Long-Term Plan for Concrete Pavement Research and Technology

TASK / STUDY NUMBER: Task 15(01)

BACKGROUND: Task 15 was originally conceived and initiated to address the need for focus and direction in Concrete Pavement Technology Program activities beyond the current work and resources. The Long-Term Plan being developed through this endeavor will chart a path from the current state-of-the-practice to a new generation of concrete pavements. It is intended to guide concrete pavement research, development and technology activities both within and outside of the Concrete Pavement Technology Program, and FHWA's post-TEA-21 Infrastructure Technology Program.

SCOPE OF WORK:

- Develop a Long-Term Plan
- Develop an Action Plan to implement the Long-Term Plan

START DATE: June 2001 (IPRF)

February 2003 (Resumption under FHWA)

END DATE: February 2005

<u>COST:</u>	Pre 2003:	\$220,831
	Current:	\$413,471 (Federal Share)
		<u>\$103,373</u> (Match)
	Total:	\$737,675

CONTRACTOR / PRINCIPAL INVESTIGATOR: Iowa State University/Ted Ferragut

STATUS: Work on this project was terminated as of June 6, 2002, due to the termination of the IPRF Cooperative Agreement. Accomplishments prior to this termination included the following:

1. Presentations before and requests for input from:
 - a. 3 committees at the TRB Annual Meeting, in addition to Session 345
 - b. Concrete pavement industry representatives in Nebraska, Iowa, Michigan, and Virginia
 - c. The International Center for Aggregate Research
2. Completion of a first draft catalogue of recently completed, ongoing, and planned research
3. An outline of plan objectives.

April 3, 2002 discussions with the project panel resulting in further refinement of approach, and agreement on schedule adjustments arising from the earlier suspension, and addition of the research database to the list of project deliverables.

A new cooperative agreement between Iowa State University and the Federal Highway Administration was signed in February 2003. The research team is updating their detailed work plan, in preparation for review by and discussion with the project panel in early April 2003.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Smoothness Criteria for Concrete Pavements

TASK / STUDY NUMBER: Task 16(01)

OBJECTIVES:

1. To determine what profile characteristics are objectionable, how to measure them, what causes them, and how to avoid creating them.
2. Determine the limits and value of smoothness specifications for concrete pavement.
3. Determine a method to identify and correct localized roughness features in concrete pavement

BACKGROUND: Research has shown that concrete pavements built smooth initially stay smooth longer than pavement built rough initially. To provide smoother pavements many states utilize incentive and disincentive provisions in their construction contracts. These provisions provide a financial incentive to contractors who exceed the required pavement smoothness while penalizing contractors who build a pavement rougher than specified. Forty-five of 52 State Highway Agencies (SHA's) utilize specifications for pavement smoothness for construction acceptance for concrete pavement. Of the SHA's using smoothness specifications for concrete pavements most currently use a profilograph or other response-type roughness meter. However, there is a growing trend to change the measurement device to inertial profiler and to more advanced roughness indices (International Roughness Index, IRI). AASHTO is currently considering adoption of a Provisional Standard for Pavement Smoothness based upon inertial profilers and IRI.

While there is substantial experience with inertial profilers and IRI for pavement management, the use of inertial profilers and IRI as a construction quality control and quality assurance device is relatively new. There are aspects of using inertial profilers and IRI for quality control and acceptance of concrete pavement that require a more thorough understanding before improved pavement smoothness specifications can be implemented on a widespread basis.

SCOPE OF WORK:

Researchers are requested to investigate the following questions:

- 1) What profile characteristics on new or newer concrete pavements are objectionable to highway users?
- 2) What are the most common objectionable profile characteristics present on new concrete pavement, what is causing them, and how do we avoid creating them?
- 3) What is the best approach to measure these characteristics?
 - a. How do concrete pavement joints and texture impact these measurements?
- 4) How smooth is smooth enough?
 - a. What is the limit of users perception?
 - b. What improvement in performance (extended service life) is obtained with improved smoothness?
 - c. What is the value of improved smoothness?
- 5) How do we identify and correct localized roughness features in new concrete pavement?
 - a. What is the "cost" of localized roughness features over a pavement's life cycle?

START DATE: March 2003

DURATION: 30 months

COST: \$500,000

CONTRACTOR / PRINCIPAL INVESTIGATOR: Soils and Materials Engineers/Starr Kohn.

STATUS: Award pending.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Subbase Design

TASK / STUDY NUMBER: Task 17(01)

STATUS: Rejected by FHWA because this was proposed as a non-competitive agreement funded by PCA.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Roller Compacted Concrete for Asphalt Overlays

TASK / STUDY NUMBER: Task 18(01)

STATUS: Rejected by FHWA because it looks at asphalt overlays and this is a concrete research program.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Communication Services for the Concrete Pavement Technology Program

TASK / STUDY NUMBER: Task 19(01)

OBJECTIVE: To improve the communication program for the Concrete Pavement Technology Program

BACKGROUND: Information about the progress and activities of the Concrete Pavement Technology Program should be provided to the program sponsors and the general public. In addition, assistance is needed in the preparation of products from the research program, in order to make application easier by the intended users in government and industry.

SCOPE OF WORK: Develop a Communications Plan and provide professional communications services to IPRF and the FHWA.

START DATE: June 2001 (anticipated) / Revised to February 2002

DURATION: 3 years

COST: \$100 K, 2001; \$175K, 2002; \$175K, 2003

CONTRACTOR / PRINCIPAL INVESTIGATOR: To be determined by open competition.

STATUS: RFP was issued. Three proposals were received and sent to the panel members. The evaluation panel meeting scheduled for August 30, 2001 was postponed. Work on this project was terminated as of June 6, 2002, due to the termination of the IPRF Cooperative Agreement. The scope of work for this task has been included in the proposed Task 65: Technology Transfer, Deployment and Delivery for the Concrete Pavement Technology Program (CPTP).

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Mobile Concrete Laboratory

TASK / STUDY NUMBER: 51 (99)

OBJECTIVE: Introduce federal, state and local transportation personnel to the state-of-the-art concrete technology in materials selection and mixture design, as well as field and laboratory testing.

BACKGROUND: Transferring new technology to highway construction agencies and constructors is often a slow process. The Mobile Concrete Laboratory (MCL), initiated by FHWA, attempts to shorten the acceptance time of new technologies and research through further refinement of these technologies. In many cases the technologies are validated in the field on actual projects and the results are documented and recommendations are made to the participating agency and the researcher. New technologies are also introduced to the state highway agencies and industry through demonstrations at the job site, equipment exhibitions at decision making events, teaching personnel how the new technology can be used and publishing articles on the results of the MCL activities.

SCOPE OF WORK: The staff of the MCL markets the MCL services to state DOT's and schedules participation on construction projects. For each project, the MCL develops a test plan incorporating both traditional concrete testing and the new technologies featured by the MCL staff in concert with the host agency and project contractor. Data gathered by the MCL is analyzed and a report of the project is prepared for the host agency's use.

The focus of the MCL for FY 2003 is to support the Office of Pavement Technologies "Long Life Pavement Technology Program"

START DATE: October 1, 2002

DURATION: Three years (base year plus two option years)

COST: \$1.9 million including travel costs for three years

CONTRACTOR / PRICIPAL INVESTIGATOR: SaLUT Inc. / Jon Mullarky and Leif Wathne

PERFORMANCE MEASURES: Performance measures for FY 2003 include; 1) providing expertise through MCL for calibration and validation of 2002 Pavement Design Guide material models in 2-3 states, 2) providing support for evaluation and implementation of performance related specifications in 2 – 3 states and 3) providing support to states utilizing best available quality control / quality assurance systems in 3 states.

TIMELINE FOR COMPLETION: Current contract will expire on September 30, 2005.

STATUS: During FY 2003 the MCL has provided services to the LTPP to evaluate the use of impact-echo on existing concrete pavements to measure the thickness in lieu of destructive cores. The MCL has eight on-going equipment loans to highway agencies evaluating these new technologies. The laboratory was on display at the Concrete Paving Conference in Austin, TX. The MCL staff also arranged and made technical presentations at an Admixture Workshop for New Jersey DOT, a High-Volume Fly Ash Workshop for Colorado DOT and a Mixture Design Workshop at the Fourth Annual Pennsylvania Concrete Seminar. Technical presentations were made at the Texas Concrete Pavement Workshop, the Self Consolidating Conference in Chicago, IL, and the ACPA First Annual Concrete Pavement Conference in Albany, NY and the SCAN Conference in Raleigh, NC.

At this time, the MCL is committed to FY 2003 projects in Florida, New York and continued work in Pennsylvania. Requests have been received for the MCL participation on field projects in California, Indiana, North Carolina, Iowa and New York. Approximately 28 % of the available base year funds have been expended and 33% of the work has been accomplished.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

Title: Quality Concrete Rehabilitation and Preservation (SP-205)

TASK/STUDY NUMBER: Task 52(98)

OBJECTIVE: Special Project 205 will develop guidance on concrete pavement rehabilitation and repair techniques as well as strategies that emphasizes the *do's* and *don'ts*, and *why* and *when* for CPR and preventive maintenance of concrete pavements.

SCOPE: SP-205 will re-examine sites and techniques studied by FHWA in the mid 1980's. As well as test and evaluate new and innovative CPR techniques and strategies through test and evaluation projects. The rehabilitation and maintenance strategies considered are full-depth patching, partial-depth patching, sub sealing, joint resealing, retrofit load transfer, and grinding and grooving.

START DATE: Program was started in 1997

DURATION: Ongoing

COST: \$300,000

CONTRACTOR /PRINCIPAL INVESTIGATOR:

PERFORMANCE MEASURES: Number of State DOT's adopting improved CPR techniques.

TIMELINE FOR COMPLETION: See Update Table below

STATUS: Ongoing

UPDATE: Field reviews have been completed. The field demonstration projects are summarized as follows:

Special Project 205: Project Status			
State	Project Description	Construction Date	Final Report Due
MN	Retrofit load transfer, short dowels, Type II Cement	1998	2003
OR	Millabrading and shot basting to remove wheel ruts due to studded tires	1998	Received 1999
WI	Partial depth repair techniques	1999	2004
OK	Monolithic bonded concrete overlay and dowel bar retrofit	1999	2003

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: High Performance Concrete Pavements (TE-30)

TASK/STUDY NUMBER: Task 53(98)

OBJECTIVE: The immediate goal of the TE-30 Project is to construct selected highway projects to explore the applicability of innovative concrete pavement design and construction concepts in the United States. The long-range goal is improvement of concrete pavement design, materials, and construction technology and equipment through innovation, research, training, and evaluation of promising pavement technology developments in other countries.

BACKGROUND: TE-30 has been an active FHWA project since 1996.

SCOPE OF WORK: Projects submitted by SHA's for TE-30 should address one or more of the following issues: increasing service life, decreasing construction time, lowering life cycle costs, lowering maintenance costs, constructing ultra-smooth ride quality pavements, incorporating recycled or waste products while maintaining quality or utilizing innovative construction equipment or procedures. Curing, curling and warping evaluations, recycling, alternative concrete mixes (RAP as aggregate, kiln dust, etc); well-graded concrete mixes will be priority activities.

START DATE: 1995

DURATION: Continuing

COST: \$approximately \$500,000 annually

CONTRACTOR/PRINCIPAL INVESTIGATOR: Various Shads

PERFORMANCE MEASURES: Incorporation of findings into standard practice by the State.

TIMELINE FOR COMPLETION:

Test and Evaluation Project 30: High Performance Concrete Pavement			
State	Description	Construction Date	Final report due
SD	Thin pavement w/ polyolefin fibers	1996	Received 1998
IA	Improved PCC mixes and mixing times	1996	Received 1998
WI	Alternate dowel bar materials, alternate cross sections	1997	Spring 2004
WI	PCC Surface Texture and Noise Study	1997	Received 2001
IL	Alternate dowel bars and installing traffic classifiers	1997,1999	2002
OH	Various sealant types or no sealants	1997-1998	2003
OH	Ground Granulated Blast Furnace (GGBF) slag in concrete pavement	1997-1998	March 2002
OH	Alternate dowel bar materials and dowel bar spacing.	1997	2002
KS	Mix designs with recycled asphalt and two-lift construction. Alternate dowel materials. 12 sections	1997	2003
IA	Alternate dowel bar materials	1997	2003
MO	Fiber Reinforced Concrete Pavement	1998	2003
VA	High-durability concrete mixes for JPCP	1998-1999	2004
VA	High-durability concrete mixes for CRCP, high reinforcement	2000-2001	2006
MN	60-year design life JPCP	2000	2005
MS	Resin Modified Pavement	2001	2006
IA	Fly-ash stabilization of PCC pavement sub grade	2000	2005
MN	Low-volume road design and curling and warping	2000	2003
MD	Fiber-reinforced concrete mixes and low-shrinkage concrete	2001	2006
KS	Super-smooth pavement: equipment and methods	2001	2006
IN	Long-life PCC Pavement	2002	2007
WI	50-year PCC pavement design	2002	2007
CA	Precast, post-tensioned pavement on I-10	2002	2004
OH	High-durability concrete mixes for JPCP, and curing techniques	2003	2005
IA	Elliptical FRP dowel bars	2002	2005
IA	Guidelines for Fly-ash Stabilization of Subgrade for PCC Pavement	2002	2004

UPDATE: Test and Evaluation Project 30 (TE-30) High Performance Concrete Pavements (HPCP) has funded approximately 25 projects since 1996. Construction of the candidate projects, once approved, are handled in accordance with existing Federal-aid procedures. Evaluation of the projects is conducted by various State agencies. Summary Report published by FHWA March 2002.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Repair and Rehabilitation of Concrete Pavements

TASK /STUDY NUMBER: FHWA Task 54 (99)

OBJECTIVE: To develop systematic, user-friendly guidelines to select:

1. The better approach between the areas of repair and rehabilitation
2. Specific materials and techniques to optimize service lives, considering performance and cost.

BACKGROUND: Many alternatives exist for the repair and rehabilitation of concrete pavements. Comprehensive guidance will be developed to enable a systematic evaluation and selection. Such a procedure must consider the properties and performance of the various treatments, the current condition and rate-of-change of condition of the pavement under consideration. A process is needed to direct the engineer through the series of decisions leading to the proper choice between repair and rehabilitation, and selection of the optimal materials and techniques.

SCOPE OF WORK: Information will be searched to determine the current state-of-the-knowledge and state-of-the-practice for repair and rehabilitation (R&R) of concrete pavement (including JPCP, JRCP and CRCP). Next, a set of guidelines will be developed to: 1) evaluate existing pavement; 2) select between repair and rehabilitation; and 3) select specific materials and technique(s) for optimal pavement performance and cost. The finalized guidelines will be put in user-friendly software.

PERIOD OF PERFORMANCE: 02/2000 - 12/2003

COST: \$ 501,674 plus additional \$92,000 to extend the project nine months, in order to make products comply with Section 508 on handicap accessibility, to work on a precast repair of a CRCP in Houston, and to cooperate with Europe on their Format Project, on "Pavement Strengthening."

CONTRACTOR/PRINCIPAL INVESTIGATOR: Dan Zollinger, TX A&M Research Foundation

PERFORMANCE MEASURES: Establish advisory panel; search literature; provide interim report; evaluate draft guidelines; finalize guidelines; provide final report and software package.

TIMELINE FOR COMPLETION: Draft final submissions - 09/03; contract completion in 12/03.

STATUS: Costs through January 31, 2003 were \$427,634 or about 85 % of the original planned cost of \$501,674. The Contractor estimated about 90 % of the original work, has been completed.

A draft version, of the windows based software, was ready with the January progress report. The program does most of what was intended. Version 2.0 will include help screens, plus other small changes. Research efforts will be initiated on variability in pavement performance to help compute life cycle costs, reconstruction as a treatment option, and analysis of CRCP. A third meeting of the technical working group with representatives from five State DOTs, the NCHRP and an FHWA field office will be arranged. A third State DOT (Maryland) should evaluate the guidelines.

A planning meeting will be held with the Houston District to further coordinate full and partial depth precast repairs for a CRCP.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Accelerated Load Testing of Ultra-Thin Whitetopping

TASK /STUDY NUMBER: FHWA Task 55 (99)

OBJECTIVE: To construct and test UTW sections at the FHWA's Accelerated Loading Facility, in order that data can be collected, to evaluate and develop design procedures. Note: an IPRF Contractor has developed an updated ACPA UTW design method, based on stationary finite element models.

BACKGROUND: FHWA and the American Concrete Pavement Association began a cooperative agreement in 1998. Response data was collected on eight sections of UTW, at the Accelerated Load Facility (ALF).

SCOPE OF WORK: Existing asphalt test sections were milled out to two depths at the ALF, and UTW placed using concrete with and without fibers, and at three different joint spacing. Instruments were placed to measure strains at various locations. The lanes were then loaded using the ALF device.

PERIOD OF PERFORMANCE: 1998 - 2003

COST: \$ 325,000

CONTRACTOR / PRINCIPAL INVESTIGATOR: James Sherwood, FHWA R&D

PERFORMANCE MEASURES: Instrument and construct UTW test sections; load and monitor the sections; supply the data to IPRF for further analysis and design. Evaluate the design methods.

TIMELINE FOR COMPLETION: The work is complete, except for the final report due in 2003.

STATUS: Field tests are complete. About \$325,000 in contract funds operated the two ALF machines for about 18 months of ALF testing, over the period May 1998 to December 2000. The FHWA Principal Investigator is preparing a final FHWA Report on the Project.

UPDATE: The loading of the eight UTW lanes and data collection is complete, including development of an ALF-UTW database. Assistance continues to be given to the ACPA and their contractors in data analysis. About 100 more 150 mm cores were extracted to conduct the Iowa shear test for bond between the PCC and HMA materials, and to determine the shear strengths of the existing HMA layers. In practically every case the bond strength was higher than the shear strength of the HMA. Sections were removed in the spring of 2002 for construction of the next ALF experiment on modified asphalt concrete pavements.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Turner-Fairbank Highway Research Center (TFHRC) PCCP Laboratory Studies

TASK /STUDY NUMBER: FHWA Task 56 (99)

OBJECTIVE: To conduct studies of concrete materials and concrete behavior in both the plastic and hardened state to pursue the goals and advance the technology of the Concrete Pavement Technology Program (CPTP).

BACKGROUND: The FHWA Office of Infrastructure R&D maintains a set of laboratories and operating staff to conduct relevant research under the guidance of the Portland Cement Concrete Pavement Team. Studies are conducted as necessary to develop new tests, verify tests and procedures coming out of contract studies and further develop test and procedures to get them ready for the next step in the delivery process. Individual projects are described on separate pages designated by alphabetical code under task 56. Thus the first study listed is Subtask 56A, and so on. The laboratory also provides technical assistance to States, the Mobile Concrete Laboratory, and other researchers at TFHRC.

SCOPE OF WORK: Depending on the needs of the program being addressed, projects conducted can range from something as simple as verification testing of fully developed test methods to developing from concept to completion test methods and procedures to fill a need in the CPTP. Current and planned projects include: Ongoing thermal coefficient testing of concrete for LTPP database; Freeze/thaw testing of concrete with marginal air void systems; Development of a rapid test for alkali-silica reactivity; Evaluating the shrinkage susceptibility of paving concretes; Evaluating the Vibrating Slope Apparatus (VSA) for measuring the workability of paving (stiff) concretes; effects of aggregate shape on workability and other properties; and effects of rapid hydration and accelerated curing on concrete properties.

PERIOD OF PERFORMANCE: 1999 - 2003

COST: \$ 480,000 in FY 03

CONTRACTOR/PRINCIPAL INVESTIGATOR: Marcia Simon, PCCP Laboratory Manager, FHWA

STATUS: Work in progress.

UPDATE: The mixture optimization project has been completed. The final report and COST user's guide have been submitted for editorial review and publication. Phase II of freeze-thaw testing is underway and will be completed by December 2003. ASR testing of concrete prisms is underway in both standard and modified versions; however, equipment problems have delayed the testing by several months. Testing will be completed in April 2004. Thermal coefficient testing is continuing using the test developed in-house (AASHTO Provisional Standard TP-60-00). Three second-generation versions of the USACE Workability device were constructed and are being used for further laboratory and field evaluation at TFHRC, University of Texas, and Iowa State University. The shrinkage study will begin in 2003 after installation of temperature/humidity control is completed. Two new studies are proposed to begin in FY 03, as the Freeze-thaw study and VSA evaluation are completed. These proposed studies involve effects of aggregate shape on workability and other properties; and effects of rapid hydration and accelerated curing on concrete properties. The objectives of these two studies will be reviewed in light of NCHRP projects involving similar subject matter before proceeding. In addition to planned research studies, assistance to the Mobile Concrete Laboratory, State DOTs, and other researchers at TFHRC is provided when needed.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Turner-Fairbank Highway Research Center (TFHRC) PCCP Laboratory Studies - Development of Standard Test for Concrete Coefficient of Thermal Expansion

TASK /STUDY NUMBER: FHWA Task 56-A (99)

OBJECTIVE: 1. To develop a standard test for measuring the coefficient of thermal expansion of concrete (CTE); 2. Use that test to measure the CTE on a series of cores from pavements in the LTPP program.

BACKGROUND: CTE is a characteristic determined by the LTPP program to have a potential influence on the performance of pavements. As a result, the concrete laboratories at the Turner-Fairbank Highway Research Center were assigned the task of developing a standard test for this property, since none existed in either AASHTO or ASTM.

SCOPE OF WORK: Available information was searched to determine how this concrete characteristic was being measured. Based on this information the most feasible approach was selected for developing a standard test which would be repeatable, easy to conduct, and relatively inexpensive to set up. After testing and validation, the test will be used to characterize several thousand concrete pavement cores collected in the LTPP program.

PERIOD OF PERFORMANCE: 1999 - 2007

COST: \$ 76,000 in FY 03

CONTRACTOR/PRINCIPAL INVESTIGATOR: Marcia Simon, PCCP Laboratory Manager, FHWA, and Jussara Ramadan, SaLUT engineer contracted to PCCP labs.

STATUS: Work in progress, 55% complete

UPDATE: A standard CTE test has been developed and finalized. It involves: sawing the cores to a standard length (178 mm/ 7 in.); grinding the ends parallel; soaking the cores to reach SSD condition; mounting the core in a measuring frame using an LVDT; putting the setup in a controlled temperature water bath; and obtaining exact specimen length change and temperature change due to a change in temperature of the bath of 40 C. This test is now AASHTO Provisional Standard TP-60-00, as listed in the 2000 volume. At least partially because of this work, the new 2002 AASHTO design guide will include CTE of the concrete as one of the input variables. Tests continue to be conducted on the LTPP cores, with an estimated 4 years of testing remaining. New water baths were purchased to increase testing throughput.

PERFORMANCE MEASURES: Approximately 1100 cores have been tested to date. Testing averages approximately 40 cores per month.

TIMELINE FOR COMPLETION: Approximately 1200 cores remain to be tested. At current rate, testing will be complete in 2007.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Turner-Fairbank Highway Research Center (TFHRC) PCCP Laboratory Studies - Concrete Mixture Optimization Using Statistical Mixture Methods

TASK /STUDY NUMBER: FHWA Task 56-B (99)

OBJECTIVE: 1. To investigate the feasibility of using statistical experimental design methods in concrete mixture proportioning, and if feasible; 2. To develop an interactive website that will assist interested parties in using these methods.

BACKGROUND: High-performance concrete (HPC) mixtures typically contain at least six component materials and may be required to meet several performance criteria simultaneously. While the ACI 211 guide for proportioning concrete mixtures and other procedures are good starting points for concrete proportioning, they do not provide information on the optimal proportions for meeting several performance criteria at the same time. As a result, trial and error, considering one factor at a time is the usual process. This approach can be inefficient, costly, and may not result in the best combination of materials. Statistical procedures have been developed for optimizing mixtures in other industries. The feasibility of applying this technique to concrete needs to be explored.

SCOPE OF WORK: In Phase I of the project the design, performance and analysis of two laboratory experiments to identify one or more concrete mixtures, which meet several performance criteria at minimum cost, will be conducted. Several statistical approaches will be tried. If one of the approaches proves feasible, an interactive website will be developed to help the user select trial batches.

PERIOD OF PERFORMANCE: 1999 - 2001

COST: \$ 0 in FY 03

CONTRACTOR/PRINCIPAL INVESTIGATOR: Marcia Simon, PCCP Laboratory Manager, FHWA

STATUS: Complete except for publication of final report and user's guide.

UPDATE: Laboratory work and interactive website software development are complete. The interactive website and user's guide are accessible online at <http://ciks.cbt.gov/cost>. The software will also be installed in the FHWA Mobile Concrete Laboratory and the TFHRC website. Final project report and COST user's guide were submitted for editorial review in January 2003.

PERFORMANCE MEASURES: Website and user's guide (complete, publication of user's guide pending), project report

TIMELINE FOR COMPLETION: April 2003.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Turner-Fairbank Highway Research Center (TFHRC) PCCP Laboratory Studies - Freeze-Thaw Durability of Concrete With Marginal Entrained Air Content

TASK /STUDY NUMBER: FHWA Task 56-C (99)

OBJECTIVE: 1. To investigate freeze-thaw durability of concrete with marginal air contents, and; 2. To investigate improvements in damage assessment of freeze-thaw test specimens.

BACKGROUND: An adequate entrained air void system in concrete is considered necessary for resistance to distress due to freezing and thawing. Typical air void parameters are 6 percent air, a specific surface greater than 600, and a spacing factor of 0.008 in or less. However, there is evidence that some concretes not meeting these criteria may be freeze-thaw durable, and there is debate as to whether some HPC with sufficiently low water-cementitious ratio require air entrainment. The SHRP project on F/T durability proposed a modified testing procedure using terry cloth covers, and use of the "quality factor" for predicting the performance of concrete F/T specimens. These modifications are being investigated to assess their usefulness in improving freeze-thaw testing.

SCOPE OF WORK: Concretes mixtures with marginal air contents will be tested using standard ASTM C666 procedures as well as the modified terry-cloth procedure suggested in the SHRP study. The quality factor will be evaluated its ability to predict the durability of the concrete at a fewer number of cycles. Additional series of concrete mixtures will be tested as needed.

PERIOD OF PERFORMANCE: 1999 - 2003

COST: \$ 45,000 in FY 03

CONTRACTOR/PRINCIPAL INVESTIGATOR: Marcia Simon, PCCP Laboratory Manager, FHWA

STATUS: Work in progress, 75% complete

UPDATE: Phase I is complete. In this phase, concretes with air contents of approximately 3 percent withstood 300 cycles of freeze-thaw testing. The SHRP terry cloth procedure was in most cases as severe as Procedure A, and is less variable than Procedure B. Mass loss was considerably greater in Procedure A (due to scaling). Phase II involves testing of concretes with air content ranging from 2.5 to 4.5 percent and w/c ratios of 0.40 to 0.50 with two different types of AEA. The first part of Phase II is complete and results indicate similar results for freeze-thaw durability. Further data analysis is underway to assess relationship of air void parameters to durability and use of quality factor for assessing damage. Because of continuing problems with steel containers and difficulty obtaining new ones, a study comparing terry cloth and containers at a range of air contents (2.7 to 4.7 percent) was performed to assess the relative severity of testing. If testing results are comparable, further testing will be conducted using terry cloth in lieu of containers. The comparison study was completed in December, 2002. The results indicate comparable durability factors, with terry cloth having slightly higher values, except for the case of non-air entrained concrete, where terry cloth was more severe. Specimens in containers experienced moderate to severe scaling (2-3% mass loss, typically) regardless of air content. The scaling probably had some effect on the durability factor. Surprisingly, nearly all of the air-entrained test beams, even the 2.7 percent air mix, had durability factors above 80% after 300 cycles. This result corroborates the Phase I results. Further investigation of the air void parameters of these mixes is underway, along with analysis of the quality factor from frequency response data. A set of tests using the Air Void Analyzer to determine air void parameters of the fresh concrete is planned for spring, 2003.

PERFORMANCE MEASURES: Phase II testing (12/02), project report (6/03)

TIMELINE FOR COMPLETION: Estimated completion date is June 2003

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Turner-Fairbank Highway Research Center (TFHRC) PCCP Laboratory Studies - Development of Alkali-Silica Reactivity Mix-Specific Test Method

TASK /STUDY NUMBER: FHWA Task 56-D (99)

OBJECTIVE: To identify a fast, reliable test for assessing ASR potential of concrete mixtures.

BACKGROUND: There is currently no rapid test method that is claimed to evaluate the ASR susceptibility of concrete mixtures. ASTM C1260 specifically states that it is to be used to assess aggregates and not combinations of aggregates and cementitious materials (although some researchers have investigated its use for that purpose). The concrete prism test developed in Canada (ASTM C1293) is more realistic, in that it tests concrete rather than mortar, but it can take a year or more to perform. Other methods have been suggested or tried, but are not recommended due to limited data.

SCOPE OF WORK: The first phase of this work will look at issues with the mortar bar test (C1260), including effects of different cements and specimen size. The second phase will use concrete prism tests at 38 C and 60 C in a test protocol, varying w/c, fly ash replacement level, and lithium dosage for a given aggregate. The test results will be used to estimate a predictive model that can be used to predict expected ASR expansion anywhere within the ranges used for w/c, fly ash, and lithium.

PERIOD OF PERFORMANCE: 1999 - 2003

COST: \$ 66,000 in FY 03

CONTRACTOR/PRINCIPAL INVESTIGATOR: Marcia Simon, PCCP Laboratory Manager, FHWA

STATUS: Work in progress, 30% complete.

UPDATE: Phase I results indicate that the use of different cements can have a significant effect on the expansion measured in C1260, even if the cements meet the criteria set forth in the test method. It is suspected that MgO in the cement could be the cause. A paper documenting this work was presented at the 11th International Conference on Alkali-Aggregate Reactivity in June of 2000. Phase II is underway. Tests are being performed for one year at 38C, for 3 months at 60 C, and for three months at 60 C using modified prisms with longitudinal holes to allow easier moisture ingress (developed at UNH). Variables include w/c (0.4 to 0.5), percent Class F fly ash replacement (0 to 30), and percent recommended lithium dosage (0 to 100). Testing at 38 C began in August 2002. Currently, repeat mixes of 38 C specimens are being performed because of concerns with some early readings. Testing at 60 C has been delayed due to equipment problems with the environmental chamber, which will be resolved by mid-March, 2003. Casting and testing of prisms at 60 C will begin in March 2003.

PERFORMANCE MEASURES: Prism testing (2/04), interim report on prism testing (12/03), final report (4/04)

TIMELINE FOR COMPLETION: Estimated completion date is April 2004.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Turner-Fairbank Highway Research Center (TFHRC) PCCP Laboratory Studies - Variation of Shrinkage Potential of Portland Cement Concrete

TASK /STUDY NUMBER: FHWA Task 56-E (99)

OBJECTIVE: To assess the shrinkage behavior of PCC paving mixtures and identify mixtures which minimize shrinkage and the associated cracking tendency.

BACKGROUND: Uncontrolled cracking in jointed concrete pavements is an area of concern when it comes to providing long service life without the need for premature repair and rehabilitation. One of the primary properties of the concrete influencing the occurrence of cracking is the amount of shrinkage that the concrete undergoes. It is known that the total shrinkage experienced by PCC depends on a number of factors, such as the aggregate volume fraction, cement properties, and curing environment. Further study is needed to investigate the effect of the combination of various concrete components and curing regime on concrete shrinkage.

SCOPE OF WORK: The concrete mixtures to be investigated will include typical paving mixtures. Initial investigations will compare different cements (of the same type, i.e., Type I) and curing regimes. Further investigations will involve combinations of cementitious materials and varying aggregate volumes. Tests will include restrained (AASHTO PP34-99) and unrestrained shrinkage (ASTM C157), early age free shrinkage, and measurement of evaporable/non-evaporable water. Emphasis will be on monitoring early-age shrinkage (up to 3 days).

PERIOD OF PERFORMANCE: 2002 - 2004

COST: \$ 48,000 in FY 03

CONTRACTOR/PRINCIPAL INVESTIGATOR: Marcia Simon, PCCP Laboratory Manager, FHWA and Jussara Ramadan, SaLUT engineer contracted to PCCP labs.

STATUS: Project scheduled to begin in FY03.

UPDATE: Equipment has been assembled to conduct restrained and unrestrained shrinkage tests and evaporable/non-evaporable water measurement. Installation of temperature and humidity control for the shrinkage lab was delayed and is expected to be completed by mid-March, 2003. Once the controlled environment room is operational, materials will be obtained and planning/testing will begin.

PERFORMANCE MEASURES: Setup CE room, initial testing, interim report, Phase 2 testing, final report.

TIMELINE TO COMPLETION: Estimated completion date is December 2004.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Turner-Fairbank Highway Research Center (TFHRC) PCCP Laboratory Studies - Evaluation of the Workability Test and the Workability of Concrete Paving Mixtures

TASK /STUDY NUMBER: FHWA Task 56-F (99)

OBJECTIVE: 1. To evaluate the operation and repeatability of the newly developed workability test device and procedure; 2. To use that test to measure the workability of a range of concrete paving mixtures, and determine what factors have primary influence on workability.

BACKGROUND: The slump test measures only part of the concrete properties that influence workability, which is the yield stress. In order to fully define workability the plastic viscosity of the concrete must also be known. Many concrete rheological devices have been developed, however none are applicable to the relatively stiff slip form paving concrete. The U.S. Army Corps of Engineers (USACE) recently developed a workability-measuring device for FHWA. The vibrating slope apparatus (VSA) quantifies the workability by measuring the time it takes for a measured mass of concrete to move out of the chute under certain vibration energy.

SCOPE OF WORK: The prototype VSA will be evaluated and tested for ruggedness, and repeatability. Design and operational modifications will be made as necessary to improve the device. After any modifications are made, the device will be used to measure the workability of a range of mixtures in the laboratory. Field evaluations will also be performed to correlate the workability index reported by the device to actual workability on the job.

The scope has been expanded based on results of the initial evaluation. The 2nd generation VSA built by FHWA will be evaluated in terms of validity and interpretation of results. The procedure may be modified from that originally specified by the USACE. After validation, the apparatus will be used in a laboratory study of the effects of aggregate shape on workability and other concrete properties.

PERIOD OF PERFORMANCE: 2000 - 2003

COST: \$56,000 in FY 03

CONTRACTOR/PRINCIPAL INVESTIGATOR: Marcia Simon, PCCP Laboratory Manager, and Jussara Ramadan, SaLUT engineer contracted to PCCP labs

STATUS: Work in progress, 75% complete

UPDATE: The three new VSAs, with updated electronics and software, were completed in December 2002. Two VSAs were loaned to the University of Texas and Iowa State University for evaluation. The remaining VSA is being evaluated further at TFHRC in this study, which will include assessment of test factors (concrete slump, chute angle, and vibration force), test procedure modifications, and analysis and interpretation methods. Use of FRP instead of steel for the chute (to decrease weight and thus increase effect of vibrator) will also be investigated.

PERFORMANCE MEASURES: Prototype evaluation (complete, report under review), initial evaluation of test factors (complete), shop drawings (complete), construction of new VSAs (complete), evaluation of VSA (1/03), aggregate effects (4/03), report (9/03)

TIMELINE FOR COMPLETION: Estimated completion date is September 2003

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Computer-Based Guidelines for Concrete Pavements (HIPERPAV II)

TASK /STUDY NUMBER: FHWA Task 57(99)

OBJECTIVE: The improved and expanded software (HIPERPAV II) program includes modules for prediction of JPCP long-term performance as a function of early-age behavior and early-age behavior of continuously reinforced concrete pavements. Two recent completed FHWA studies have also been incorporated to provide capabilities for optimization of concrete mix designs to meet specific performance criteria, and predict early-age behavior of dowel bars in rigid pavements.

BACKGROUND: Previously, FHWA developed a computer program, HIPERPAV, to provide guidance to the pavement engineer in the selection of materials and mixture design, pavement design, and construction procedures to avoid early-age cracking in JPCP. The purpose of this project is to investigate and provide guidance on the performance of JPCP beyond the first 72 hours, and to investigate and provide guidance on the early-age behavior of CRCP.

SCOPE OF WORK: Information will be searched in order to determine the current state-of-the-knowledge and state-of-the-practice of the prediction of long-term behavior of JPCP, and the early-age behavior of CRCP.

PERIOD OF PERFORMANCE: 2000 - 2004

COST: A modification to the contract was made to the contract including: Tasks G - workshops and technical support and Task H - further improvement of the HIPERPAV-II software. Increased the contract value from \$745,250 to \$953,343. Extended the period of performance to January 31, 2004.

CONTRACTOR/PRINCIPAL INVESTIGATOR: Robert Rasmussen, Transtec Group, Inc.

PERFORMANCE MEASURES: Establish advisory panel; complete and evaluate the software in the field; include guidelines from other studies (development of software prototypes for dowel analysis and the mix optimization) in the software; prepare the final version of the software and the final report.

TIMELINE FOR COMPLETION: Work in progress. First release of the software will be on April 31, 2003 (will include improvement reflecting the feedback received during the pilot workshop). The second release (final) will be before January 31, 2004, which will include feedback from audience in the workshops.

STATUS: Work in progress. Three workshops were conducted in Pennsylvania, IOWA, and Michigan. The modifications and improvements are being made to the HIPERPAV II software program to reflect feedback received from the Technical Group. The following are the cumulative percentage work for different tasks: G 35%, H 0%, and other tasks 100% (except the Final Report 98%). Cumulative percentage amount paid to the contractor is 94%.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: The Use of Precast Concrete Panels to Expedite Highway Pavement Construction

TASK /STUDY NUMBER: Task 58-A (98)

OBJECTIVE: To investigate the feasibility of using precast concrete technology as a means to expedite concrete pavement construction.

BACKGROUND: Precast concrete construction methods have been developed which are viable alternatives in applications such as buildings and bridges. One of the primary benefits of precast components is the speed of construction. Precast elements can be cast in controlled conditions at a precasting yard, far in advance of when they will be needed, then stockpiled and transported to the jobsite as necessary. Allowing time for concrete to cure before opening to traffic is a time-consuming phase of concrete pavement construction. The use of precast elements would eliminate this step while optimizing curing for the precast slabs.

SCOPE OF WORK: Information was searched in order to determine the current state-of-the-art of precasting and the paving industry. Pavement types were evaluated for their potential to be built using precast components. Concepts for the design and construction of precast pavements were identified and evaluated for their feasibility. Finally, recommendations were developed for designs and concepts with the potential for implementation, and also for monitoring the performance of trial installations.

PERIOD OF PERFORMANCE: 1999 - 2000

COST: \$ 100,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: Frank McCullough, CTR, U of TX, Austin; in cooperation with the Texas DOT.

STATUS: Work COMPLETE.

UPDATE: The feasibility study has been completed; the results are published as Center for Transportation Research Report Number 9-1517-1. The proposed panels are to be cast with continuous shear keys in the edges to aid with alignment when assembled. The panels are pre-tensioned in the transverse direction during fabrication, and post-tensioned in the longitudinal direction during construction. A follow-up project to work with several States to conduct field trials is underway.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: The Use of Precast Concrete Panels to Expedite Highway Pavement Construction - Phase 2: Pilot Studies

TASK /STUDY NUMBER: Task 58-B (98)

OBJECTIVE: To investigate the feasibility and demonstrate use of precast concrete technology as a means to expedite concrete pavement construction.

BACKGROUND: Precast concrete construction methods have been developed which are viable alternatives in applications such as buildings and bridges. One of the primary benefits of precast components is the speed of construction. Precast elements can be cast in controlled conditions at a precasting yard, far in advance of when they will be needed, then stockpiled and transported to the jobsite as necessary. Allowing time for concrete to cure before opening to traffic is a time-consuming phase of concrete pavement construction. The use of precast elements would eliminate this step while optimizing curing for the precast slabs.

SCOPE OF WORK: To build off the successful feasibility study, use of precast concrete pavements will be investigated through construction of pilot project to demonstrate manufacturing and construction techniques. Pilot studies will be conducted on temporary roadways or non-service facilities.

PERIOD OF PERFORMANCE: 2000-2002

COST: \$ 100,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: David Merritt, CTR, University of TX, Austin;

PERFORMANCE MEASURES: Successfully demonstrate the use of the system in the field.

TIMELINE FOR COMPLETION: Pilot project in Texas and California contracted by fall 2002.

STATUS: Pilot project completed on I-35 frontage road in Georgetown, Texas, November 2001. Pilot project on I-10 in California under construction in October 2002.

UPDATE: Final report expected by mid -2003. Paper prepared for 7th International Conference on Concrete Pavements, Orlando, FL 9/2001. Paper prepared for TRB Annual meeting, 2002, Paper prepared for PCI conference, October 2003. Paper prepared for TRB Annual Meeting, 2003

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: The Use of Precast Concrete Panels to Expedite Highway Pavement Construction – Phase 3: Demonstration Projects

TASK /STUDY NUMBER: Task 58-C (98)

OBJECTIVE: To demonstrate the use of precast, post-tensioned concrete pavements as a means to expedite concrete pavement construction.

BACKGROUND: Precast concrete construction methods have been developed which are viable alternatives in applications such as buildings and bridges. One of the primary benefits of precast components is the speed of construction. Precast elements can be cast in controlled conditions at a precasting yard, far in advance of when they will be needed, then stockpiled and transported to the jobsite as necessary. Allowing time for concrete to cure before opening to traffic is a time-consuming phase of concrete pavement construction. The use of precast elements would eliminate this step while optimizing curing for the precast slabs.

SCOPE OF WORK: To build off the successful feasibility study and pilot projects by demonstrating precast, post-tensioned pavement construction in filed applications. This project will provide for engineering support and evaluation of this technology for up to four projects.

PERIOD OF PERFORMANCE: 2003-2004

COST: \$250,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: TBD

PERFORMANCE MEASURES: Successfully demonstrate the use of the system in the field.

TIMELINE FOR COMPLETION: It is anticipated to demonstrate this technology on two projects in 2003 and 2004.

STATUS: Proposals are currently being solicited

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Nondestructive and Innovative Testing Workshop

TASK / STUDY NUMBER: 59 (00)

OBJECTIVE: Introduce federal, state and local transportation personnel to currently available nondestructive testing technology that can be used to improve QC/QA testing of new concrete as well as investigation of defects for existing concrete pavements and bridges.

BACKGROUND: Transferring new technology to highway construction agencies and contractors is often a slow process. The FHWA developed and presented several one-day nondestructive testing workshops to interested state highway agencies in the mid 1990's. The workshops were well received and a decision was made within FHWA to broaden the scope of these workshops and have a consultant put together a 2-day hands-on workshop.

SCOPE OF WORK: The contractor for this work performed a literature search of existing nondestructive testing equipment for early age testing of concrete and identifying defects in concrete at later ages. The contractor identified those pieces of equipment, which were practical and included them in the hands-on workshop, which will be presented on a national basis to interested state highway agencies.

START DATE: September 2000

DURATION: Contract extended to March 31, 2003

COST: \$386,000

CONTRACTOR / PRICIPAL INVESTIGATOR: SAIC

PERFORMANCE MEASURES: Workbook and course materials due 3/31/03

TIMELINE FOR COMPLETION: Completion date for workshop materials is March 31, 2003.

STATUS: Maryland SHA hosted pilot workshop on April 9 – 11, 2002. Over 35 people attended the workshop. The participants included personnel from MD SHA, FHWA, other government agencies and industry. Based on the comments received, it was decided to hold a second pilot workshop and include a third instructor. Overall the comments were very positive and the participants agreed that the workshop should be presented on a national basis. A second pilot workshop was also presented for the Ontario Ministry of Transportation by the MCL staff.

The workshop presented information on the following devices: maturity, pull off (bond test), air void analyzer, impact-echo and concrete thickness gauge. For each of these devices there was either a hands-on session where the participants operated the devices or a demonstration to the group as a whole. A session on new and emerging technologies also discussed such technologies as: FHWA NDE Validation Center Activities (HERMES II ground penetrating radar, infrared thermography, and wireless measurements systems), pullout, workability device, cover meter, spectral analysis of surface waves, ROSAN, dynamic friction tester, and the circular track meter.

The revised cost proposal received by the contractor to incorporate changes from the workshop and deliver ten workshops was significantly over the Government estimate and it was mutually agreed upon by both parties that the contractor would finalize the workshop materials and deliver them to FHWA. The funds remaining in the contract would be used to award a new contract for the delivery of the workshops. It is anticipated that the new contract would be awarded by October 2003 and delivery of the workshops would commence in early 2004. Approximately 99% of the funds available for the development of the workshop materials and delivery of the pilot workshop has been expended and 95% of the work has been completed.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Curing of Portland cement Concrete Pavements

TASK /STUDY NUMBER: FHWA Task 60(99)

OBJECTIVE: To develop guidelines for selecting curing materials and procedures that will assure adequate curing of pavement concrete, given the variation in concrete mixture proportions and climatic conditions at the time of paving.

BACKGROUND: Proper curing of concrete has a major influence on the performance of that concrete in service. Because of the relatively large surface area to volume ratio for pavements, this statement is particularly true for concrete pavements. Curing as used in this project includes both moisture control and temperature control of the concrete. Guidance is needed for materials and procedures selection in order to assure proper curing for pavements in a range of situations.

SCOPE OF WORK: Information is to be searched in order to determine the current state-of-the-knowledge and state-of-the-practice for curing requirements, materials and procedures for PCCP. The search will include available tests for evaluating the efficiency of various curing materials and procedures in controlling temperature and moisture of the concrete after placing and finishing. After evaluating the results of the information search, guidelines will be developed for determining the required curing regime in terms of allowable temperature and moisture ranges of the concrete, and then selecting curing materials and procedures to provide adequate curing based on concrete mixture proportions and climatic conditions expected during construction. Field tests to monitor and verify the adequacy of curing shall also be recommended.

PERIOD OF PERFORMANCE: 1999 - 2003

COST: \$ 395,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: Dr. Toy Poole, Waterways Experiment Station, U.S. Army Corps of Engineers.

PERFORMANCE MEASURES: Establish Technical Advisory Panel; collect information; prepare an interim report; complete and evaluate the guidelines; final version of the guidelines; final report.

TIMELINE FOR COMPLETION: Complete and evaluate guidelines (12/01); draft final report and guidelines (09/02); revised final report and guidelines (12/31/02); re-revised final report (03/03) final report (05/03).

STATUS: Work is somewhat behind schedule, as reflected in the revised completion date noted above. Reorganization and staff reductions at WES have contributed to the slowness of progress. The first drafts of the deliverables were reviewed, and indicated a major shift in the researcher's approach was needed. The prepared a second draft of the final report which was much better, but still needed additional streamlining and shift of emphasis. The contractor is now working on the final version of the report to address the latest set of review comments. That report is due by the end of March 2003.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Evaluation of Initial PCC Performance-Related Specification Systems

TASK /STUDY NUMBER: FHWA Task 61(99)

OBJECTIVE: To begin the implementation of performance-related specifications (PRS) by having State highway agencies develop, put into use, and evaluate a PRS system tailored to their needs.

BACKGROUND: Over the past 25 years, there has been a growing interest in the development of PRS for highway pavement construction. PRS systems are similar to quality assurance specifications; however the measured acceptance quality characteristics (e.g. concrete strength, slab thickness, initial smoothness) are directly related to pavement performance through mathematical relationships. Performance is defined by key distress types and is directly related to the future maintenance and rehabilitation costs and user costs of the highway. This link between acceptance quality characteristics and future life-cycle costs provides the ability to develop rational and fair contractor pay adjustments that depend on the as-constructed quality delivered for the project. Several FHWA research projects on development of PRS have now been completed, and guidance for implementing PRS is now available in the form of: (1) a prototype PRS; (2) a 19-step procedure for developing PRS; and (3) PaveSpec software.

SCOPE OF WORK: State highway agencies wanting to implement PRS will follow the information available in FHWA report FHWA-RD-98-155, "Guide to Developing Performance-Related Specifications for PCC Pavements". Each of the agencies will develop the PRS as a special provision for use on one or more suitable PCC pavement construction projects. In developing the PRS, communications shall be established and maintained with the contractor community and industry associations. Implementation will include necessary education of potential contractors (through a bid conference) as well as education/training of State DOT and construction personnel involved in the construction projects.

PERIOD OF PERFORMANCE: 1999 - 2004

COST: \$ 225,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: INDOT and FDOT are the first 2 agencies that have agreed to participate. Indiana hired Purdue University to help them; and Florida hired ERES to help them. At least 2 more agencies will be sought in FY 2003.

PERFORMANCE MEASURES: Each state develops a PRS; uses the PRS on one or more projects; prepares a report on the results.

TIMELINE FOR COMPLETION: INDOT developed and used a PRS on a project in 2000. A 2nd project was started in 2002 and will be completed in 2003. FLDOT has developed a PRS that will be used on a project in 2003.

STATUS: Work in progress. INDOT is currently planning to develop and use PRS on a 3rd project.
Percentage of work completed: 80% (as of 3-1-03)
Percentage of funds expended: 80% (as of 3-1-03)

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Potential Adverse Effects of High-Smoothness Specifications on Concrete Pavement Performance

TASK /STUDY NUMBER: FHWA Task 62 (01)

OBJECTIVE: 1. To assess whether any activities carried out during the paving process in order to achieve some specified level of smoothness could have detrimental effects on concrete properties and pavement performance. 2. To provide guidance on adjustments to materials and procedures in order to avoid such potential effects.

BACKGROUND: There has been a continuing trend among highway agencies to specify smoother and smoother pavements. The requirements are steadily being raised in response to the user's increased expectations and the paving contractor's increased proficiency. However, while contractors are finding ways to attain the specified smoothness, it is not clear that the result is always an overall improvement in pavement performance. Like all materials and construction quality characteristics, smoothness should be considered as having an optimal level. Obviously it is undesirable to have a newly constructed pavement that is too rough. Alternately, very smooth pavements, if they fail prematurely, are also undesirable. This project will investigate the potential for adverse effects on concrete properties and the performance of concrete pavements from trying to achieve some currently specified levels of smoothness.

SCOPE OF WORK: The contractor will investigate the potential for high-smoothness specifications to have an adverse effect on concrete pavement performance. As a part of trying to establish a cause and effect relationship, the contractor will collect available information on concrete pavement construction that achieved high levels of initial smoothness, but resulted in a decrease in one or more of the properties of the concrete which are essential to good pavement performance. Selected pavements will be sampled and tested to supplement available information. Data analysis will be conducted to achieve clearer understanding of the mechanisms involved. Recommendations will then be developed for avoiding adverse effects on concrete properties and pavement performance while conducting paving activities to achieve the specified smoothness.

PERIOD OF PERFORMANCE: July 2001 – July 2003

COST: \$ 388,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: Dr. Starr D. Kohn, Soils and Materials Engineers, Inc.

PERFORMANCE MEASURES: Form technical panel; collect information; prepare interim report and work plan; conduct work plan; develop guidelines; prepare final report.

STATUS: Work in progress. Literature review has been completed. Initial meeting of the technical panel was held. Work plan was modified and approved. Collection and analysis of data is underway. Contractor has fallen behind schedule and it is likely that time extension will be requested.

Percentage of work completed: 25% (as of 2-16-03)

Percentage of funds spent: 20% (as of 2-16-03)

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Inertial Profile Data for PCC Pavement Performance Evaluation

TASK/STUDY NUMBER: Task 63(02)

OBJECTIVES:

1. Determine if the magnitude of JPCP slab curvature can be related to pavement performance
2. Determine the extent of JPCP slab curvature allowable under specific environmental and support conditions to provide long-term performance.
3. Identify construction methods or design characteristics to achieve recommendations

BACKGROUND: It has been known for some time that the changes in shape of PCC slabs due to construction conditions (built-in curvature) and environment (temperature curling and moisture warping) in a jointed pavement system have an influence on pavement performance. Exactly how performance is impacted by slab shape and the magnitude of changes to slab shape throughout its life cycle, has not been adequately documented. Many previous attempts to quantify the impact of slab shape on performance or determine the shape of PCC slabs on in-service pavements have been limited by insufficient sample size resulting from use of manual methods for determining slab shape.

Recent advances in inertial profiling technology developed at FHWA's Turner-Fairbank Highway Research Center and advances in computer technology make it possible to measure reliably the shape of very large numbers of PCC pavement slabs over a short period of time and perform analysis of this data. These measurements can be repeated to develop a time-history of pavement slab shape. This technology was recently demonstrated by a high-speed inertial profiler that performed a detailed profile survey of four lanes of a 24 km Interstate pavement four times within a 24-hour period (Sixbey, et al. 2001). Sixbey found that the magnitude of curvature of the slabs surveyed varied from positive 15 mm to negative 15mm using best-fit curve and simulated straightedge. The daily change in slab curvature was frequently measured at 5-7mm over a 22C pavement temperature range. It is hypothesized that slab shape changes in response to construction conditions; diurnal temperature gradients may have a significant role in pavement performance.

With the evolution from empirical pavement design to mechanistic pavement design, determination of changes to the shape of slabs in jointed PCC pavement and the distribution of slab curvature on in-service pavements is very critical.

SCOPE OF WORK: Collect inertial profile data using advanced inertial profiling technology for 1000 lane miles of jointed PCC pavements, determine slab shape changes over a range of environmental conditions, relate findings to pavement performance. Guidelines will be developed for maximum slab curvature to achieve extended life pavements.

Products of this research shall include written guidelines and computer based guidelines that will focus on the impacts that design and construction decisions will have on slab curvature and ultimate long-term performance. The guidelines will contain recommendations for SHA engineers including suggested specifications and contractor incentive/dis-incentive terms to achieve recommended curvature characteristics

START DATE: August 14, 2002

DURATION: 30 months

COST: \$920,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: Transtec Group, Inc/Rob Rassmussen

PERFORMANCE MEASURES: Incorporation of guidelines in performance-related specifications (PRS), quality assurance for extended life PCC pavements, use of guidelines in refinement of mechanistic-based design models.

TIMELINE: Guidelines delivered by June 2005. Validation could be completed by 2006.

STATUS: Data collection to start April 2003

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Computer-Based Guidelines for Job-Specific Optimization of Paving Concrete

TASK /STUDY NUMBER: FHWA Task 64(02)

OBJECTIVE: To develop computer-based guidelines for optimizing materials selection and mixture proportioning for job-specific paving concrete.

BACKGROUND: Over the last several years the FHWA, IPRF, NCHRP and others have conducted a number of studies that dealt with various aspects of the effect of concrete components on the performance of the resulting concrete (using those materials) in concrete pavements. The wealth of information now available is too great to be practically assimilated and combined from existing guidelines, reports, tables and predictive models in order for a pavement or materials engineer to derive the optimal mix for a given paving project. Therefore, a coordinated effort is needed to take the results of previous work and integrate them into a computer-based system that will guide the concrete materials engineer in selecting the optimal mix for a particular project. Factors that need to be considered include pavement structural design (loading effects), early-age and long-term environmental effects, the construction process, desired service life, available local materials and cost.

SCOPE OF WORK: Results of recently completed and on-going studies on materials selection and mixture design for concrete pavements will be reviewed and evaluated in order to develop guidelines for optimizing the resulting concrete for specific projects. Where available information for completing the guidelines is not sufficient, additional information shall be developed. Once draft guidelines have been developed, they will be evaluated in a series of projects including a range of pavement designs and exposure conditions. The final version of the guidelines will be available in a user-friendly Windows-based computer program.

PERIOD OF PERFORMANCE: 2002 - 2005

COST: \$ 834,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: Transtec, Inc.

PERFORMANCE MEASURES: Establish advisory panel; collect available information, especially from on-going and recently completed studies; prepare interim report including proposed framework for computer software structure and work plan to complete and evaluate the guidelines; develop guidelines and software system according to approved work plan; test software/guidelines in the field; finalize guidelines; prepare final report.

TIME LINE FOR COMPLETION: August 2006.

STATUS: Work in progress, 5% complete

UPDATE: Contract was awarded on August 30, 2002. A technical panel consisting of several state DOT concrete engineers, contractors, and various trade associations, was formed. The first meeting took place in November 2002. At that meeting, the panel provided direction and feedback to the contractor on their proposed approach. Since then, the contractor has been collecting information (literature review) and evaluating approaches to designing the final computer-based product. An interim report discussing the technical scope, information gaps, options for software development, a framework for the guidelines, and a detailed work plan for the remainder of the project is due in April/May 2003. A second panel meeting will be held after review of the interim report.

CONCRETE PAVEMENT TECHNOLOGY PROGRAM

TITLE: Technology Transfer, Deployment and Delivery for the Concrete Pavement Technology Program (CPTP).

TASK/STUDY NUMBER: FHWA Task 65 (03)

BACKGROUND: This contract will provide the engineering and communication services needed for the technology transfer, deployment and delivery of products resulting from the Concrete Pavement Technology Program (CPTP). The CPTP comprises research and development projects that have been identified by FHWA's partners and customers in the States, industry and academia. The CPTP supports the goal of the Infrastructure Office of Pavement Technology to advance long-life practices that improve pavement durability, smoothness, and cost effectiveness throughout the National Highway System; and, FHWA's national goals to reduce user delays, reduce costs, improve performance, and foster innovation.

SCOPE OF WORK: The scope of the work to be performed under this contract will be defined both by the products that result from the CPTP and by the communication and outreach strategy that is proposed by an offer or and accepted by the Government. The technology transfer program is for the benefit of FHWA's customers and partners and it will be planned and executed in a timely and cost-effective manner. The program will clearly demonstrate the value of the products resulting from the CPTP and deliver benefits to a variety of end-user groups in the highway community including the States, industry, and academia.

PERIOD OF PERFORMANCE: The planned period of performance is a minimum of one year up to a maximum of five years, subject to the availability of funding.

COST: Procurement request number 50-53-3065, approved 20 December 2002, with total estimated cost of \$5.0 million allocated as follows:

- Base year 2003, \$2.0 million
- Option year 2004, \$900,000
- Option year 2005, \$900,000
- Option year 2006, \$900,000
- Option year 2007, \$300,000

CONTRACTOR/PRINCIPAL INVESTIGATOR: Contracting documents prepared through March 2003 for posting on the FedBizOpps site on the World Wide Web are as follows:

- Sources Sought
- Request for Proposals

PERFORMANCE MEASURES: Successful performance requirements are as follows:

- Preparation of a detailed status report for CPTP projects and products
- Development of a marketing plan, and
- Implementation of technology transfer, deployment and delivery activities in a timely and cost effective manner.

TIMELINE FOR COMPLETION: To be determined.

STATUS: Estimated solicitation release date is 1st quarter FY 2003.

UPDATE: Pre-award activities completed as shown above.